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INVESTIGATION OF TRANSITION OF LAMINAR BOUNDARY LAYER INTO TURB--ETC(U)
AUG 78 B V BOSHENYATOV, V V ZATOLOKA
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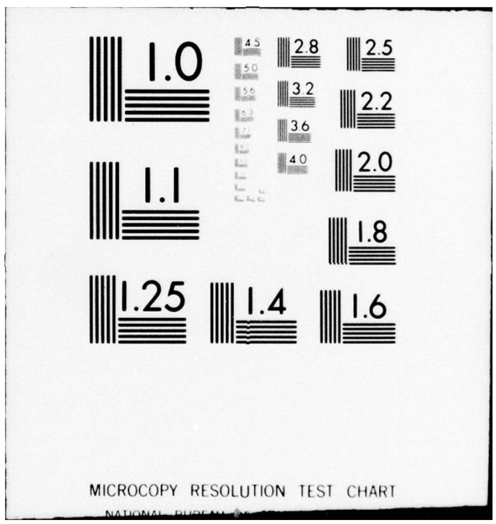
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AIR FORCE SYSTEMS COMMAND

INVESTIGATION OF TRANSITION OF LAMINAR BOUNDARY LAYER INTO TURBULENT IN HYPERSONIC IMPULSE TUNNEL IT-301 AT M = 8-11.5

by

B. V. Boshenyatov, V. V. Zatoloka
M. I. Yaroslavtsev

FOREIGN TECHNOLOGY DIVISION

EDITED TRANSLATION

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*<u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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INVESTIGATION OF TRANSITICN OF LAMINAR EOUNIARY LAYER INTO TURBULENT IN EYPERSONIC IMPULSE TUNNEI IT-301 AT M = 8-11.5

B. V. Boshenyatov, V. V. Zatolo ka, M. I. Yaroslavtsev.

In an impulse tunnel there is conductec a study of the phenomenon of transiticn of laminar boundary layer into turbulent on sharp cones at Mach numbers 8-1.5; Re = 2-8•10⁷ I/m. An optical methcd of determination of the transiticn is prcposed, based on the property of the turbulent boundary layer tc withstand without separation more intense pressure jumps than the laminar boundary layer [1, 2]. Fig. 122 shows the relaticnships of the separation angle β to the time in three different starts of the tunnel, distinguished from each other by the level of Re numbers at M = 8.3. On the graphs of $Re_e - \frac{\rho v e}{\mu}$ are placed pcints, ccrresponding to sharp decrease of the separation angle β. It is clear that sharp decrease of β occurs approximately at the same $Re_e(t)$ = (5-6)•10⁶ (spread +- 8 o/o).

The Reynolds numbers of the transition, determined in IT-301 by this method, agree (see Fig. 2) with data (Fig. 123) obtained in steady-state conditions. Data on the transition are compared taking into account the effect of single Reynolds number. For IT-301 $Re_n \sim$ 0.3-0.4.

By investigations on the transition in IT-301 it is experimentally proven that in IT-301 there are achieved Re numbers, sufficient in order to obtain turbulent hypersonic boundary layer on models of medium dimensions (150-300 mm).

Furthermore, it is shown that the duration of the operating mode in IT-301 is sufficient for the study of flow with separation of boundary layer. In this case flow around the models also carrys a quasi-steady character.

REFERENCES

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2. G. N. Abramovich, Applied gas dynamics. M., "Nauka" (Science), 1969.

CALCULATION OF FRICTION AND HEAT EXCHANGE IN NOZZLES WITH TURBULENT BOUNDARY LAYER DURING NONEQUILIBRIUM OUTFLOW OF PARTIALLY DISSOCIATED AIR

Ye. G. Zaulichnyy.

During calculation of the expansion of dissociated air in nozzles at high parameters of stagnation and large Mach numbers the correct calculation of flow parameters acquires much significance in connection with the nonequilibrium character of the chemical reactions and oscillatory relaxation and distortion of the nozzle profile due to growth of the boundary layer at its walls [1-3].

For air in the region of temperatures up to 6000 °K and 10 $10 \leqslant P_0 \leqslant 1000$ atm (abs.) it is sufficient to appoximately consider the nonequilibrium character of inviscous flow in the nozzle by the method of "instant freezing", having taken the dissociation of oxygen in this case as the basic process [3, 4].

Using the Lighthill model for ideally dissociated gas and the assumption about isentropicity of flow taking into account equations of continuity, motion, energy for one-dimensional flow in nozzles, it is possible to easily obtain the condition of search of the "freezing section" and to determine the flow parameters along the length of the nozzle

$$\frac{(0.231 - C_\zeta)\, e^{-2/T_\zeta}}{C_\zeta(1 + C_\zeta)\, T_\zeta} = \frac{2}{F}\left(\frac{\alpha F}{\alpha x_1}\right)_\zeta \frac{u_\zeta}{\Phi} \qquad \text{(I)}$$

Here $\Phi = \frac{981 K_r \rho_0 x_{1L}}{\mu_0^2 u_*}$ is the parameter characterizing the ratio of speeds of recombination to the speed of the stay of particles in the nozzle, K_r - speed of recombination of oxygen atoms, for several reactions K_r is written as total, μ_0 - molecular weight of air, x_{1L} - characteristic length of nozzle, C, ρ, U - concentration of dissociated atoms, their density and speed; F - area of cross section of nozzle; T - temperature, ζ - "freezing", α - dissociation; 0.231 - mass portion of oxygen in air.

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